ENTOMOLOGICAL
SOCIETY OF
BRITISH COLUMBIA

PROCEEDINGS

OF THE

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APRIL--1920

NUMBER ELEVEN
ECONOMIC SERIES

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BRITISH COLUMBIA ENTOMOLOGICAL SOCIETY.

PROCEEDINGS, 1920.

THE ONION-MAGGOT.

By R. C. Treherne, Entomologist in Charge for B.C. Dominion Department of Agriculture, and M. H. Ruhman, Assistant Provincial Entomologist.

A GREAT deal of conflicting evidence is before us on the control of this injurious insect. Even now after one year's concentrated study of this insect at Vernon in the "Dry Belt," where it is yearly assuming greater importance, and after two years' observations on its general activities and habits in that district, we are unable to claim to have devised a scheme for control which completely satisfies us. Our investigations have led us along definite channels which may result in something definite after a while.

In glancing over the literature on this insect we find the following suggestions for its control:—

"Liberal amounts of tobacco-dust." (O'Kane.)

"Clean up and burn refuse after harvest." (Sanborn, Oklahoma.)

"Rotation of crop, destroy infested plants, and apply carbolic-acid emulsion to soil." (Conradi, South Carolina.)

"Destroy refuse, wild mustards, and cruciferous weeds; rotate crops; fertilizers; frequent surface cultivation; tobacco-dust and sulphur in drill-rows with seed; hellebore; and slaked lime as a dust to the soil. (Lovett, Oregon.)

"Cultural control measures and use of trap-crops with deterrents of sand and kerosene, carbolized lime, charcoal, hellebore, tobacco-dust, and dry lime." (Britton, Connecticut.)

"Control by repellents and fertilizers; take up infested bulbs and destroy." (Pettit, Michigan.)

These suggestions for control are representative of the remedial measures adopted for this fly until about the year 1913. During 1913, 1914, and 1915 the poisoned-bait method for control was devised and used extensively in Eastern United States. Eastern Canada has also used this new method with great success. In brief, the recommendation called for the use of 5 grammes of sodium arsenite dissolved in ½ pint of molasses and water. This mixture was applied to the fields of onions as soon as the onions were up in about two applications a week until the latter part of June. It was either whisked out of a bucket across or in the rows of onions or it was sprayed in coarse drops from a hand-sprayer. The object

to be attained was briefly to induce the female flies to feed upon the poisoned liquid from the drops that fell either on the soil, or on the onion foliage, or on the foliage of weeds and grass growing alongside the fields. In this way the flies would be killed and the first generation of maggots would be prevented. Later on, owing to the labour involved in this operation of spraying, ordinary pie-dishes were used at the rate of from twenty to forty to the acre, with a quantity of the same poisoned liquid in each dish. At the present time it is my understanding, although there are few published records of the work, that both the spray method and the pie-dish method are employed by onion-growers in Eastern Canada and Eastern United States.

In order to test the efficacy of the treatment in British Columbia, steps were taken in 1918 and in 1919 to run a series of experiments. Since the summer of 1914 the annual losses suffered by onion-growers through the work of the onion-maggot have been gradually increasing in severity. In the spring of 1918 several growers evinced the desire to take steps to effect control. Unfortunately, the Entomological Branch, at this time, were unable to undertake any definite control measures or to study the life-history owing to pressure of other work. The growers were advised on the method of using the sodium-arsenite and molasses bait. The pie-dish method of using the bait was suggested, for the reason that it was felt that the spreading of the bait in coarse drops of spray would not suit our conditions in the Okanagan.

Accordingly, two fairly large onion-growers set out twenty pie-dishes to the acre, using the bait consisting of ¼ oz. of sodium arsenite and ¼ pint of molasses to a gallon of water, and starting them going about the end of April. These pie-dishes were maintained during May and until June 14th, after which time they were allowed to dry for a month, being renewed for a few weeks in July. On June 14th, at the suggestion of these growers, an examination of the onion plantations was made, and advice was further requested as to how to save the plantation which was severely injured by maggots. Examination revealed the fact that the onions were heavily infested despite the use of the baits over the period mentioned. The growers had made an honest endeavour to retain moisture in the pie-dishes, but it was a difficult matter owing to the rapid evaporation. Dishes filled at noon were found to be absolutely dry by 3 o'clock in the afternoon. Fresh water at the rate of 1½ pints to each dish was added daily, and once a week a fresh solution of bait was made up and poured into the dishes. Close examination of the fields on June 14th showed that very few unhatched eggs were present and that few flies were in evidence flying over the plantations. The onions had been thinned in May by hand, but despite this fact it was evident that a heavy loss from the maggot was to be anticipated. Judging from the conditions, it would appear that the point of heaviest infestation had been reached; it was therefore suggested that the crop be rethinned and that all infested onions be pulled up and burnt. One grower with 8 acres of onions arranged in two blocks, 5 and 3 acres each,

separated by 100 yards of an alfalfa-field, objected to the process of rethinning owing to the increased cost. He was prevailed upon, however, to do the rethinning on 5 acres, leaving the remaining 3 acres untouched. The results of this work were most surprising. The rethinned 5 acres yielded a crop at the end of the year of 25 tons to the acre, while the untouched 3 acres produced a total of 900 lb.

At the close of the year the statement was made in our annual report that results from the use of the poisoned bait had been unsatisfactory, but that the bait was still believed to be satisfactory. It seemed essentially necessary, however, to conduct a close study of the life-history of the fly in order to correlate its habits with the use of the bait. The onion-growers, further, were very anxious to obtain more information leading towards control; hence it was decided to include the study of this fly in the outline of experiments for 1919.

In 1919 an extensive experiment with the use of sodium-arsenite and molasses bait (¼ oz. to ¼ pint) was carried on at Vernon Specially constructed cans were made, filled with water, which allowed a certain quantity of water to filter down on to felt pads arranged in trays. The felt pads, having been soaked in the bait and a few ounces of the poisoned liquid poured over them, retained their moisture for four to ten days under all temperatures. Twenty of such bait-cans were placed to the acre between the rows of onions and 2½ acres in an 8-acre field in all were treated in this experiment. The bait-cans were set on May 14th, five days before any eggs were laid in the field, and they were maintained continuously until the end of June, and again during the first two weeks in August.

Samples of the poisoned liquid were taken two or three times a week from the trays and fed to flies. The adults were observed to be in distress within five minutes of actual feeding and were completely stupefied in thirty minutes, and this condition prevailed throughout, despite frequent dilutions from rain and from the water in the reservoirs above the felt pads. Flies left to their own devices in the laboratory in the presence of drops of poisoned bait gave a 100-per-cent. mortality in less than twenty-four hours. Circular fly-traps arranged in the field, each baited with different essential oils and mixtures, undoubtedly showed that molasses was the most suitable substance to attract the flies. Despite these two favourable circumstances, we are unable to claim that the poisoned-bait method is a satisfactory control under such field conditions as prevailed at Vernon, B.C., in 1919. Oviposition took place on seedling onions and on volunteer onions (from the crop of the previous year) in such numbers that it was impossible to state that the poison bait had any effect in checking oviposition. In several instances volunteer onions gave as many as 500 eggs to the plant during May and June.

The influence of a suitable type of volunteer onions as a trap-crop for the first generation presents a phase of onion-maggot control that must be regarded very highly. In the 8-acre experiment of 1919 a number of sections of onion-seedling rows were examined daily for oviposition, and it may be stated that there was no material difference in oviposition in the

baited area or in the non-baited area. Further, there was no indication that the maggot attack was more severe in any one part of the field over any other.

The first male flies appeared in the field on May 10th; the first females a few days later. The height of the oviposition period was not passed until June 6th. Eggs were laid in the field on May 19th, and continually from this date until August. The length of the larval period varied from sixteen to twenty-nine days and the pupal period from fourteen to twenty-six days. The earliest pupa formed was found on June 14th. Second-generation adults appeared on July 7th. The first generation of flies extended over a period between May 10th and July 7th; the second generation until August 23rd, after which time third-generation flies might be expected. Two generations occur and doubtless a third, but the life-history notes on the last generation have not been obtained with accuracy. A great many notes have been obtained on the habits of the fly and particular attention has been paid to temperatures and weather conditions.

OBSERVATIONS ON THE CONTROL OF THE ONION-MAGGOT (HYLEMYIA ANTIGUA).

BY M. H. RUHMAN.

Onions have been extensively grown in British Columbia for a number of years, particularly in the Okanagan Valley. In the year 1914 growers began to complain that cutworms were destroying their young plants. On investigation it was found that the onion-maggot was present and responsible for most of the trouble. This was most evident in small kitchen-gardens, the large commercial plantings not suffering sufficiently to attract attention. The few short gaps that did occur in the rows of onions were attributed to faulty seeding or cutworms. In the year 1915 growers began to get alarmed, as extensive injury was being done by the onion-maggot. The recommendations for control—i.e., the removal of infested plants in the middle of June and their destruction by boiling or burning, and the destruction after harvest of onion-tops and undersized onions, usually left on the field to be ploughed under—did not appeal to them and comparatively little was done to control the pest. The onion-maggot has now become so serious a menace that control measures must be undertaken or the growing of onions commercially must soon be discontinued.

The adult of the onion-maggot is a fly somewhat resembling the the common house-fly, a little smaller and more slender, but with proportionally larger wings, and is grey in colour. The life-history of the fly in British Columbia is not well known; the insect passes the winter in the pupal stage in the ground and occasionally in stored onions, in which they may have pupated. The adult fly emerges in the spring; the earliest Canadian record is of an adult captured in the third week in May at Ottawa (1). The number of eggs laid at one deposition may vary from

one to fifteen (2) and are laid at the base of the young plants or in the soil close to a plant. Later broods may lay them in the axil of the leaves when the plants are well grown. The incubation period of the eggs may vary from three to ten days (2 and 3), according to climatic conditions. The larval period (2) is completed in two to three weeks in green onions, onion-sets, and small-seeded onions, but in onions stored from the previous year may require from four to five weeks to complete their larval period. The pupal period (2) of the summer broods is from nine to sixteen days, with an average of eleven to twelve days. There are probably three broods of flies each season.

When the eggs are hatched the young larvæ immediately work their way down the plants and commence feeding, and as at this time, the end of May or early June, the onions are quite small, one larva may destroy a large number of plants, with the result that long stretches in each row of onions may be completely destroyed, making it unprofitable to continue cultivation. Later when the bulbs are forming a number of larvæ may be found in one bulb. The top of the onion in this case may be completely killed, but the lower part of the bulb may still continue to grow owing to the roots being uninjured.

The losses to the onion-growers occasioned by the maggot during the years 1917 and 1918 in the Okanagan Valley were very heavy, amounting to thousands of dollars. In some instances the crops were so badly injured during the early summer that it was unprofitable to continue cultivation and the crops were consequently ploughed under. It is well to state, however, that yields were also greatly interfered with by other conditions, such as wireworm attack and poor quality of imported seeds. So far as is known, this insect has no other host-plant, but to determine if this insect was able to complete its life-cycle on other food, Messrs. Severin & Severin (2) conducted a number of experiments. Freshly laid eggs were placed in contact with growing radishes, and it was found that the onion-maggot completed its life-cycle in twenty-nine to thirty-five days. A second experiment was tried by placing the eggs on fresh horse-droppings, with the result that the maggots completed their life-cycle in twenty-nine to thirty-one days; one maggot taking fifty-two days to complete its life-cycle. It is therefore evident that the fly can adapt itself to other food than the onion, but in a general way, under strictly natural conditions, most investigators agree that the onion-maggot attacks onions and no other crop.

Control.—A large and varied number of methods of control for the onion-maggot have been advocated at different times. Few of these appear to have been tested on a commercial scale. Many of them are too expensive to be considered, and a few of them, such as carbolic-acid emulsion, kerosene emulsion, and hellebore, are only useful in the kitchen-garden.

Professor Sanders (4), having determined that the pre-oviposition period of the female fly covered a period of ten to fourteen days, thought it feasible to prepare a poison bait that would attract the adult fly during the pre-oviposition period. Accordingly, experiments on a commercial scale were

conducted by the Professor and others in Wisconsin between 1913 to 1916. The bait used was the Sanders formula, 5 grammes sodium arsenite dissolved in 1 gallon of boiling water, to which is added ½ pint of molasses. This bait was applied as a spray with a small compressed-air sprayer altered to give a coarse spray, or might be applied by a whisk-broom, the operator walking up and down the fields about every twelfth or fourteenth row and releasing a quantity of spray at every four paces. In this manner about 3 gallons of the bait were applied to 7 acres about twice a week. The first application was made as soon as the onions came up and were continued until the later part of June. From the end of May the amount of spray applications was doubled. From the end of June to the end of August a series of fly-traps were used to test various modified baits. Of the baits tried, the Sanders formula with the addition of sliced onions proved 300 times more attractive than other baits tested. A further experiment was tried by distributing the bait in pie-tins at the rate of fifteen to twenty-five tins per acre. The amount of success obtained with these baits in the field did not come up to expectations, being attributed to continuous rains. Mr. T. J. Headlee, of New Jersey, where similar tests had been made over two years under drier conditions, states that very satisfactory results were obtained. In the Okanagan Valley in the spring of 1918, owing to the heavy loss in the onion-crop the previous year, a local grower was induced to try the poison-bait method to protect his crop. He was instructed to distribute tin pie-plates at the rate of twenty to the acre, and to prepare the poison by dissolving ¼ oz. of sodium arsenite in 1 gallon of boiling water and to add to this ¼ pint of molasses. This bait was placed in the plates and renewed weekly. Frequent visits were paid to this field to observe results. Early in June it was found that, owing to our dry conditions, the renewal of the bait once weekly was insufficient owing to the rapid evaporation of the water, and dishes were found to be quite dry one or two days after the bait had been placed in them; it was therefore found necessary to renew the baits daily during the months of June and July.

The adults of the onion-maggot were found to be attracted freely to the bait when moist, but none were observed near dry or partly dry dishes. Instead of renewing the bait daily, water was added to keep it moist, fresh bait being only distributed weekly. The result was that considerable infestation was noticed in the middle of June. It was then suggested that a second thinning of the crop be undertaken and that infested onions be removed and burned. Owing to the acreage under consideration and the expense of a second thinning, also because there was considerable doubt on the part of the grower as to the final results, the work was undertaken on 5 acres of the crop which consisted of home-grown seed, and was more vigorous than the balance of the crop which was sown to imported seed. The work was carefully done and the poisoned bait continued; by the middle of July the rethinned onions were showing a perfect stand and the poisoned bait was soon after discontinued. The harvested crop from the 5 acres of

rethinned onions was estimated to average 24 tons per acre; the balance of the field was a total loss.

From the observations made on the experiment the following conclusions were drawn: The fresh bait was attractive to the fly. Where the plates had been allowed to dry no flies were attracted to the poisoned molasses remaining. Instead of weekly renewal of the bait as suggested by the Wisconsin experiments, it was found that daily renewal was necessary under our dry conditions. Instead of daily renewal of the bait, water was added to the plates to replace evaporated moisture; this possibly was not done until after the bait was so dry that the water would not mix readily with the poisoned molasses; consequently the flies were able to obtain moisture from the bait without absorbing the poison. In the middle of June infestation was found to be very heavy, and the second thinning appears to be mainly responsible for the excellent crop obtained, the cost of which was certainly warranted, but careful work is necessary to make the thinning a success.

In the spring of 1919 experiments will be conducted to find, if possible, a more attractive bait; also methods of application more suitable to our dry conditions in relation to the life-history will be tested.

References.

(1) Gibson & Treherne, Ent. Branch, Ottawa, Bul. 12.
(2) Severin & Severin, Jour. Econ. Ent., Vol. 8, 1915, p. 342.
(3) Donald J. Caffrey, Ent. Rept., Connecticut, 1911, p. 287.
(4) N. F. Howard, Journ. Econ. Ent., Vol. II., 1918, p. 82.

SOME NOTES ON THE TENT-CATERPILLAR.

BY A. B. BAIRD, ASSISTANT ENTOMOLOGIST, ENTOMOLOGICAL BRANCH, OTTAWA.

During the past summer the tent-caterpillars have been attracting the attention of every one in and around the Cities of Vancouver and Victoria, and judging from the supply of egg-masses to be seen at the present time this pest may be expected in even greater numbers in 1919 unless control-work is undertaken in a thorough and systematic manner. These caterpillars must not be confused with another destructive species, the fall web-worm (**Hyphantria sp.**), which were also very abundant in Vancouver and the Lower Fraser Valley last year, but which appear much later in the season, usually about the end of July, after the tent-caterpillars have disappeared.

Two distinct species of this insect occur in British Columbia — the common or orchard tent-caterpillar (**Malacosoma pluvialis**) and the forest tent-caterpillar (**M. disstria var. erosa**). Their life-histories, habits, and control are quite similar, however, and they will be treated together in this

short paper. In common with many of our native insects, this pest is subject to years of abundance followed by several years of scarcity, and this is but one of the many outbreaks recorded in the history of our continent. The caterpillars are voracious feeders, and during the years of abundance much damage is done, in addition to the unsightly appearance and inconvenience caused by their presence. The history of the forest tent-caterpillar as recorded in our available literature is given briefly on the accompanying chart. A more detailed account may be found in the Annual Report of the Entomological Society of Ontario, 1916.

It will be noted that outbreaks have occurred at intervals of eight to ten years and the average duration was about three years.

Life-history and Habits.—The insect spends the winter as a tiny caterpillar in the egg-shell. The eggs are deposited in masses of from 250 to 400 in the form of rings or masses on the terminal twigs and smaller branches of the trees. The masses are covered with a shellac-like material which serves to hold the eggs together and protect them from the weather as well.

The caterpillars emerge from the eggs in the early spring and feed upon the opening leaves. Those from each mass, or from several masses in the case of an outbreak, usually keep together and feed in congress until nearly full-grown. As the caterpillars grow they moult, or cast off their outer skins several times, and the dry skins are often found in large numbers on the tree-trunks and taken by many to be dead caterpillars.

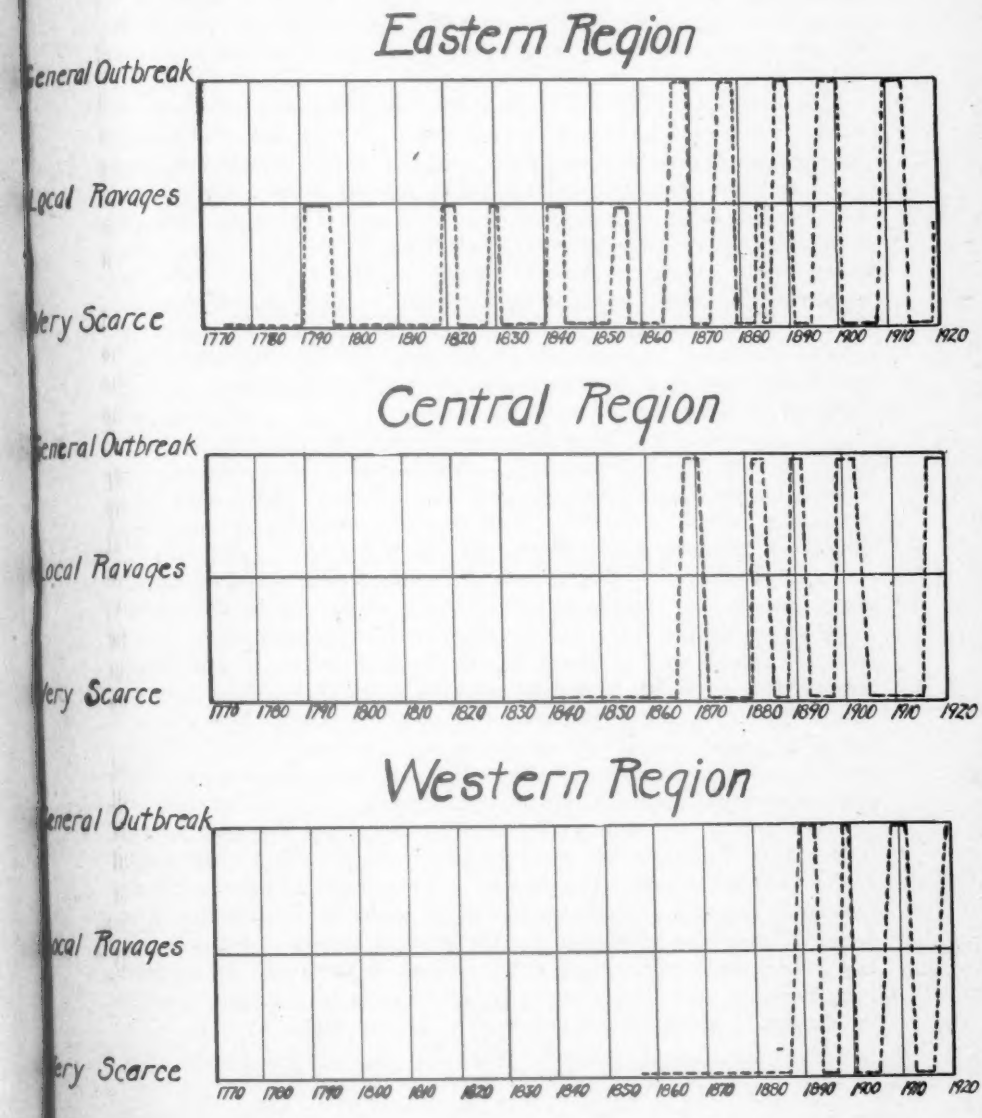
When the caterpillars become full-grown, which usually requires about eight weeks, they spin their cocoons and enter their chrysalid or pupal stage. The cocoons may be found fastened to the leaves of trees, in crevices of the bark, under fence-rails, under the eaves of houses, and in many other places.

The moths emerge in from two to three weeks. They are medium-sized moths and are reddish-brown in colour, with two more or less distinct bands across each front wing near the middle. They fly at night, and after mating the males die within a day or two and the females deposit their eggs as soon as they have found a suitable location. The females will not deposit their eggs until they have been fertilized and may live for two or three weeks. There is only one generation a year, the eggs deposited in July remaining on the trees until the following spring.

Control.—The control of these insects in forest lands is not at present economically possible, but the following control methods are applicable to orchards, city lots, shade-trees, and parks:—

(1.) *Destruction of Egg-masses.*—During the winter months the egg-masses are easily seen on the twigs, especially on the smaller trees, and much good can be done by removing and burning them before hatching-time, and although some masses will be missed the caterpillars from these will be more easily controlled.

(2.) *Destruction of Clusters of Caterpillars.*—The forest tent-caterpillars may be removed when they are in clusters on the trunk or lower branches on the tree, either by scraping them off with a hoe or stiff wire



History of the Forest Tent Caterpillar in North America. The dotted lines indicate the abundance of the insect.

brush or by applying a strong spray of kerosene emulsion directly on the caterpillars. The caterpillars of the other species may be quite readily destroyed by burning with a torch when they are resting in their web or tent on the trees.

(3.) *Spraying.*—This is perhaps the simplest and most economical method where quite large areas are infested, such as in parks and orchards. Any reliable stomach-poison may be used, the most available being Paris green and lead arsenate. Of these, lead arsenate is to be preferred on account of its better adhesive qualities. The spraying should be commenced as soon as possible after the caterpillars hatch, so that they may be killed before much damage is done to the trees. Also the older caterpillars require much stronger spraying mixtures, and as the foliage increases the amount of spray necessary becomes proportionately greater; hence it is doubly economical to spray early. Use 2½ lb. of lead arsenate to 40 gallons of water; or 1 lb. of Paris green with 2 lb. of quicklime (to prevent burning) to 160 gallons of water.

(4.) *Jarring the Trees.*—The caterpillars usually drop to the ground when the tree on which they are feeding is jarred or shaken, so if one strikes the trunk and larger branches with a padded mallet most of the caterpillars will fall off, and the trunk may be banded with cotton or some adhesive mixture to prevent their return up the tree.

(5.) *Banding.*—Banding is more or less complementary to all the other control measures in order to prevent caterpillars from infested trees near by crawling on to trees which have been freed from the pests. Several materials may be used for banding, but the most convenient and effective material is a special tree tanglefoot prepared by the O. W. Thum Company, Grand Rapids, Michigan, the makers of sticky fly-paper. This should be applied as a band around the trunk about 4 or 5 inches wide and 4 or 5 feet from the ground. It must be renewed, if necessary, by scraping the surface and removing caterpillars which get stuck up in it.

The *natural control* of these insects was discussed in a paper prepared by Mr. J. D. Tothill for last year's annual meeting of this Society and will be found in the report of that meeting. I would merely mention the fact that insect parasites and predators, diseases, birds, weather conditions, and such-like, have been responsible for the years of scarcity noted in the past and will no doubt reduce the present outbreak in due time. In the meantime, however, we must make use of artificial methods of control to prevent the damage to our property which must otherwise result.

FURTHER NOTES ON THE TENT-CATERPILLAR AND ITS NATURAL CONTROL, 1919.

BY A. B. BAIRD.

The tent-caterpillar outbreak was again very severe in and around the Cities of Vancouver and Victoria, causing much damage to shade and fruit trees and making the streets and parks very unsightly. The web-building species (**Malacosoma pluvialis**) was predominant and spread over a much larger area than the forest tent (**M. disstria var. erosa**). The latter was confined chiefly to a part of the Uplands District in Victoria, and in Vancouver to a section between Seventh and Thirtieth Avenues and extending for some fifteen to twenty-five blocks east and west of Main Street. Occasional caterpillars and small colonies were found scattered all over the infested area, but only in the above-mentioned areas was it in the majority. The species are equally destructive and their life-histories, habits, and control are practically the same, the chief difference being that **T. pluvialis** hatches about a week earlier in spring. Owing to the very cold, backward spring the trees had nearly all leaved out before the larvæ issued, which is a rather unusual condition. The cold weather also reduced the work of insect parasites to a large extent.

As conditions in Vancouver and Victoria are quite different, it is necessary to discuss them separately.

In Vancouver overcrowding and diseases were the chief control factors noted, and together they were responsible for the death of large numbers of the larvæ. It is rather difficult to estimate the percentage thus destroyed, but judging from the abundance of egg-masses it was not sufficient to prevent another outbreak next year. Insect parasites were almost entirely absent. Apart from a few egg parasites which destroyed about 2 per cent. of the eggs and a species of tachinid fly which destroyed less than 1/10 of 1 per cent. of the pupæ, none were found, although several careful searches were made in the field covering most of the infested territory, and each week collections of 100 larvæ and pupæ were made from different sections, which were either dissected or reared through in trays in the insectary. If parasites *were* present they must have been exceedingly scarce and localized. Birds of various kinds devoured a small percentage and insect predators, such as ants and carabid beetles, no doubt also took a small percentage. None of these factors, however, have had any appreciable effect in reducing the outbreak, and there will be another outbreak to face this coming season if the eggs now on the trees hatch and yield the usual number of caterpillars.

In Victoria conditions were quite different. Insect parasites were very abundant in early June—sufficient under ordinary conditions to control the outbreak. The cold, windy weather, however, reduced their effectiveness, so they were almost a negligible quantity in the control. Millions of parasite-eggs failed to hatch in time to do their deadly work, and millions more were not deposited at all, or were deposited out of season. One tachinid fly deposited eggs on fully 50 per cent. of the caterpillars, but, so

far as we could tell from field observations and rearing hundreds of them in the insectary, less than 1 per cent. of these eggs hatched before being moulted off by the caterpillars. Another tachinid which deposits eggs on the leaves of the food-plants is only active on hot, sunny days, and deposited most of its eggs too late to be of value in the case of **M. pluvialis.** It was, however, useful in the control of the **erosa** outbreak in the Uplands; these caterpillars being ten days to two weeks later, and the parasitism there ran as high as 20 per cent. Two species of Hymenoptera were present in small numbers—**Campoplex (Ameloctonus) validus** and a species of **Rogas.** Both of these attack the very small caterpillars and are often useful parasites. Some other parasites were found attacking the pupæ, but these were also in negligible numbers. Overcrowding and diseases were very active and important factors, and were successful in reducing the outbreak in all parts of the city, with the exception of the Uplands, which was fairly free from disease.

To sum up, we see that, although the natural enemies of the tent-caterpillars have been successful in reducing the outbreak in Victoria, it is far from being under complete control, and it can increase so rapidly that it will be necessary to assist nature in every way during the coming summer in order to render these pests innocuous. In Vancouver much greater efforts will be necessary. Last year recommendations were made to the Councils of both cities with a view to assisting them in reducing the depredations of the insects, but the results fell far short of being satisfactory owing to a lack of any co-ordinated campaign.

OBSERVATIONS ON THE USE OF POISON BAITS FOR THE CONTROL OF CUTWORMS IN 1918.

BY M. H. RUHMAN.

For some years a mixture of Paris green or white arsenic and bran has been advocated for use against cutworms. The usual recommendation was the application of the poisoned-bran bait round the base of young orchard trees, or its distribution along the rows of plants, or its being placed in small piles under shingles among the plants to be protected. In lectures on control and in most publications emphasis is placed on the fact that the Paris green or white arsenic is liable to cause injury to the plants or trees if the bait is placed in contact with them. Evidence to this effect came to the writer's notice in the spring of 1918 when called upon to investigate the cause of the complete destruction of two separate plantings of 2,000 tomato-plants and approximately 2 acres of beans. On examination it was immediately evident that the plants had been burned by some poison applied to prevent cutworm injury. On inquiry it was found that a bait had been prepared consisting of 2 lb. of white arsenic to 50 lb. of bran mixed with sufficient water to make a crumbly mass. The white arsenic was used

owing to difficulty in obtaining sufficient Paris green. The grower was not aware of the necessity of avoiding contact between the bait and the plants, and had been in the habit of applying the bait to the rows of plants without troubling to avoid contact. No ill effect had resulted in previous years, but Paris green had always been used in place of white arsenic. Greater care, therefore, is necessary in using white arsenic than Paris green, but care should be exercised on all occasions with growing plants with either arsenical. On another occasion a representative of a commercial firm called for advice as to the planting of 80 acres which had been prepared to receive tomato-plants and which had been baited for cutworms. Thirty plants set the previous evening had been cut down overnight and it was feared that heavy losses would result if the field were planted. A visit was paid to this field, and on examination of the plants destroyed an average of seven cutworms to each plant was found. The preparation and handling of this acreage was entirely in the hands of Chinamen, who insisted that the injury was not due to cutworms, as they had carefully baited the land to destroy them by placing about a tablespoonful of poisoned-bran bait on the spot each plant was to occupy. This bait on examination was found to have been improperly mixed, at least 50 per cent. of the bran being free of poison. The method used to apply the bran was not only unsatisfactory, but must have taken considerable time. It was advisable, therefore, to rebait the entire field, the formula given being in the proportions of: Bran, 50 lb.; Paris green, 1 lb.; molasses, 2 quarts; lemons, 6 fruits; and water, 5 gallons.

This bait is prepared by thoroughly mixing the bran and Paris green in their dry state. One gallon of the water is heated, in which the molasses is dissolved, which is then added to the remaining 4 gallons of water. The juice of the lemons, and their pulp and peel after being finely chopped, are then added. The liquid is then gradually mixed with the bran and Paris green and thoroughly worked until all the bran is equally moistened. This bait was, on the occasion mentioned above, and should at all times be prepared just before use and broadcasted over the ground immediately after the ground has been prepared for planting, but before planting or seeding has taken place. It should be applied over the entire acreage as thinly as possible in the cool of the evening. This quantity of bait will cover about 7 acres if thinly broadcasted.

No further visits were paid to this field, but on inquiry at the end of July it was reported that not a single plant had been lost through cutworms.

On another occasion a small lot of about 1 acre, which had been prepared for planting, but was abandoned owing to the enormous quantity of cutworms present, was taken over by two boys for a war-garden. The writer personally baited this lot with the mixture before described, and obtained 100 per cent. results overnight. The boys were put to work to hunt for live cutworms the following morning, and, although over 3,000 dead cutworms were gathered, they failed to find a live one. This lot was then planted to beans, with no loss for the remainder of the summer through cutworms.

The mixture used is a modification of the Kansas grasshopper bait, and was first used by the writer in the spring of 1917 on a small city garden-patch with perfect results.

In many districts cutworms are always present in sufficiently large numbers to warrant the application of a poisoned bait every spring to protect the crops. The broadcast method has the advantage that no green food is present to detract the cutworms from the bait, which is consequently greedily eaten. The desired results are thereby obtained.

Owing to war conditions the cost of material in the spring of 1918 was high, being: Bran, 50 lb., $1.05; molasses, 5 lb. (approximately 2 quarts), 50 cents; lemons, 6 fruits, 25 cents; Paris green, 1 lb., $1; making a total of $2.80 for material sufficient for about 7 acres. With the labour of preparation and application the total cost should not exceed 55 cents per acre. Under normal trade conditions the lower cost of material would reduce this to approximately 40 cents per acre.

Every endeavour should be made to treat land before planting, as the quantity of bait required per acre to treat planted land greatly exceeds the broadcasting method, and the time required to apply the bait, so as to avoid direct contact with the growing plants, can bear no comparison. Furthermore, the effectiveness of the bait is considerably reduced, as when succulent young plants are present the cutworms are liable to give them preference to the bait.

The most important point in the preparation of the bait is the thorough mixing of the bran and Paris green. These ingredients must be mixed in their dry state in the endeavour that each flake of bran shall bear a particle of the poison. The water must not be added in bulk, but worked in gradually and thoroughly. If this is not done the addition of the water will free a considerable percentage of the poison from the bran-flakes, thereby making the bait less effective, it being remembered that only a small quantity of the bait will be consumed by one cutworm.

GENERAL RECORDS OF WORK CARRIED ON IN THE UNITED STATES AND CANADA IN 1918.

By R. C. TREHERNE.

In Control of Cabbage-worm lead arsenate and calcium arsenate gave best results (1 lb. powder, 2 lb. paste to 40 gallons, with 1 lb. laundry-soap). Zinc arsenate, tobacco-dust, lime, of no use at all. Dusting is becoming the recognized way of controlling cabbage-infesting insects.

(*a.*) Arsenate of lead powder or Paris green mixed with 20 times its bulk of hydrated lime or gypsum.

(*b.*) Sulphur, 50 parts; tobacco-dust, 40 parts; lead arsenate, 10 parts; used in cheese-cloth bag by shaking, or by regular dusting-machine, costing approximately $30.

Control of Clothes-moth—Sulphur fumigation destroys adults and larvæ, not eggs. Heat at 110° Fahr. for 30 minutes kills all stages. Larvæ and eggs killed by dipping for 10 seconds in water at 140° F. Camphor and naphthaline are the only materials fit to use in closets, etc.

Control of Cockroaches.—Sodium fluoride has given best results. Borax is good, but its action is slow.

Red-spider Control.—Use soft-soap solution, 4 per cent. if buds are closed; soft soap 1 per cent. and nicotine 3 per cent.; soft soap 1 per cent. and quassia 2 per cent. A new spray where red spider is really bad has been devised in California, uniting lime-sulphur, miscible oil, glue, and water.

Sprays—Arsenate of Lead Spreaders.—Sage-brush tea, 1 lb. to 1 gallon; allow to stand for 12 hours, 5-1,000. Casein lime: 3½ grammes quicklime and 1½ grammes casein; grind in mortar; 4-8 oz. to 100 gallons.

Calcium Arsenate is not safe for general recommendation. It is suggested for apples, potatoes, pear, but not for plum, cherry, or peach. Used alone, it burns. One to ten of lime is safe for apple. Excess of lime prevents arsenic going into solution.

Dusting is rapidly replacing liquid sprays for many insect and disease controls. The machinery and dusting mixtures have not as yet reached a stage of perfection. To-day, relative cost is higher. They are using 80 to 85 per cent. sulphur, 10 to 15 per cent. powdered arsenate of lead, with 10 per cent. diluent, at 3 lb. per medium tree. Cherries may be dusted without arsenate within a few days of picking. Dusting is cheaper for large trees, 50 per cent. dearer for medium trees, and much more expensive for small trees. Liquids hold better to leaves. Diluents or carriers are silt, gypsum, talc, limestone. In general, liquid sprays are advocated until dusting equipment is improved.

Lime-sulphur is liable to cause injury with trees in poor vitality, applications in unusual heat, direction of spray with high humidity and high sunshine record.

Nicotine has been shown by several investigators to be an effective ovicide, in some cases by itself destroying 80 per cent. of eggs. With soap, 4 lb. to 100 gallons (B.L. 40, 1-1,200), 100 per cent. mortality has been shown. A new combination with nicotine extract and oleic acid has been brought forward. Olein, from which the acid is made, is the chief constituent of the fatty oils, such as olive-oil, whale-oil, etc.

Soluble Sulphur (a sodium sulphide) is advocated from several quarters, but is not generally recommended. If used, it appears that calcium arsenate is safer than lead arsenate in combination. The formula suggested is: 2½-3½ lb. soluble sulphur; 1¼ lb. calcium arsenate; 15-20 lb. hydrated lime; 100 gallons water. Liver of sulphur (potassium sulphide) cannot be used with arsenicals.

Residues from Spraying.—Experiments have been conducted to show the effect of feeding hay cut from beneath trees sprayed with arsenicals. With cattle, no effects at 3 lb. arsenate to 50; symptoms of poisoning, 6-50; serious, 10-50. The same applies to sheep, but not so with poultry. As to

sprayed apples, 0.5 mg. is left on one apple at 3-50; medicinal dose is 2-5 mg.; dangerous dose, 60-120 mg. Thus no danger unless 120 apples are eaten at one time.

House-ant Control.—One pound sugar dissolved in 1 quart water, to which add 125 grains (approximately ¼ oz.) sodium arsenate. Boil until thoroughly dissolved and add about a tablespoonful of honey. Set out with sponge in shallow dishes.

Rice-weevils.—Do not breed in stored, sun-dried wheat containing moisture up to 8 per cent. In 9 per cent. moisture they lie dormant, and above 9 per cent. are active. Weevils in flour may be controlled by heat, 113° Fahr. at 24 per cent. relative humidity.

Carbon-bisulphide fumigation for pea-weevil is used in Kentucky at 1 lb. per 83 cubic feet; a greater strength than this destroys germination.

Pear-slug.—Parthenogenesis proved; virgin females laid eggs in spring, giving rise to virgin females entirely. Males are rare.

Aphides.—It must be realized that three kinds of aphides may be found associated in a single cluster on an apple-tree. These are known as the green apple-aphis, the European grain-aphis, and the rosy aphis.

The Green Apple-aphis (**A. pomi**).—Eggs are laid in autumn on apple; hibernates as egg. Hatching occurs when nearly all buds show some green, forming, after moults, stem-mothers; wanders around, settles in buds. In ten days reproduces about forty young, giving rise to wingless viviparous females, winged females, and intermediate forms. The number of young produced in earlier generations is higher than later, varying as 55 : 30 : 12, according to season. Winged forms are not produced as a result of lack of food, and not necessary for the propagation of the species. Thus two theories are disposed of. Intermediate forms are variants, but reproduce normally; seventeen generations occur. Sexes are formed by the winged and wingless females; usually commence in August or September. The proportion of males to females is ten to ninety. Plural mating takes place, an average of six eggs per female being laid.

The Rosy Aphis (**A. malifoliæ**).—The most injurious species. A variation is shown in the life-history from the green apple-aphis. The winged forms are again seen. All form wings and migrate to secondary host-plant. Eggs are laid in apple. Hatch at same time as **A. pomi.** Stem-mother in fifteen days starts to reproduce, laying about seventy-one young. Then five to seven generations follow; the first wingless, later winged; approximately 122 young being produced per individual. The winged forms become migrants in late May. Settle on plantains; produces eighteen young, each wingless. No aphides of this species are now in the apple; all are on plantains. Forty-seven young are produced in geometrical ratio in plantain. Winged forms in later generations in plantain are formed, which fly back to apple in September. Males are formed in plantain in late summer and fly to apple at a time when the first migrants have produced young of the oviparous type. Seven eggs per female are laid on apple-twigs in October.

The European Grain-aphis (**A. avenæ**) has a similar life-history to the rosy aphis, but it uses the grain and grasses as alternate hosts instead of plantains. The only important point—this aphis hatches ten days earlier.

Aphis-control.—Buds too far expanded makes spraying difficult. In all recommendations for spraying it is stated that the best results attend a dormant spray as the buds are nicely broken. It costs money to spray; often not desirable; depends on degree of infestation and on early spring temperatures, etc. There is a certain stage in the embryo which is susceptible to outside agencies. A high temperature of 65° Fahr. in February often kills most aphides. The study is a very complicated matter; the critical temperatures are not yet determined. In dry air 4 per cent. eggs hatch; in 22 per cent. moisture, 12 per cent.; in 63 per cent. moisture, 20 per cent.; in 100 per cent. moisture, 36-46 per cent. hatch. Lime-sulphur tends to harden shell and nicotine tends to penetrate. Spray 1-9 lime-sulphur and nicotine 1-500.

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